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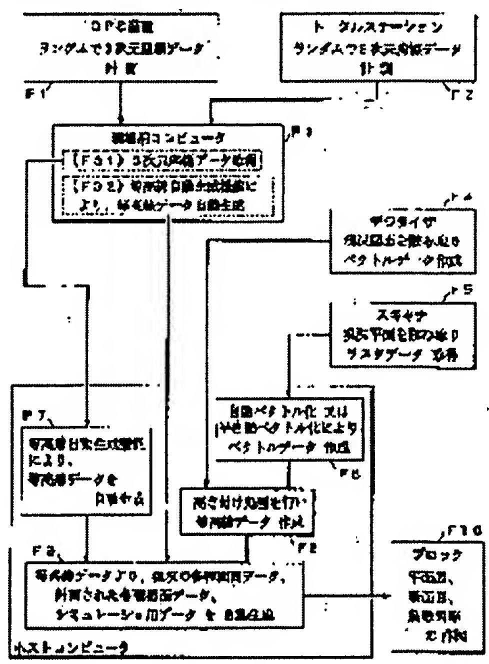
(71)Applicant : JEKKU:KK

(72)Inventor : KOBAYASHI TETSUYA
HAMAMURA TAKESHI

(54) LAND FORMATION PLAN DESIGN SUPPORTING SYSTEM AND RECORDING MEDIUM

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a land formation plan design supporting system capable of efficiently obtaining the present surveying terrain data with high accuracy and preparing plan, bird's-eye view or the like reflecting the data within a short time.
SOLUTION: The land formation plan design supporting system produces contour data (F32, F7 and F8) from three-dimensional coordinate data (F31) simply measured at a random spot by GPS device (F1), total station (F2) or the like within a short time and three-dimensional mesh data (F9), and since plan and bird's-eye view data are prepared on the basis of these data (F9), measured data is faithfully reflected on plan/sectioned drawing and bird's-eye view without committing any input error, and the present situation can be easily and surely confirmed. In this system, since a view simulation picture corresponding to the bird's-eye data is indicated, the present three-dimensional inspection can be further and surely confirmed. By making a comparison between new an old three-dimensional mesh data, the volume of soil can be calculated.



機能ブロック図(1)

LEGAL STATUS

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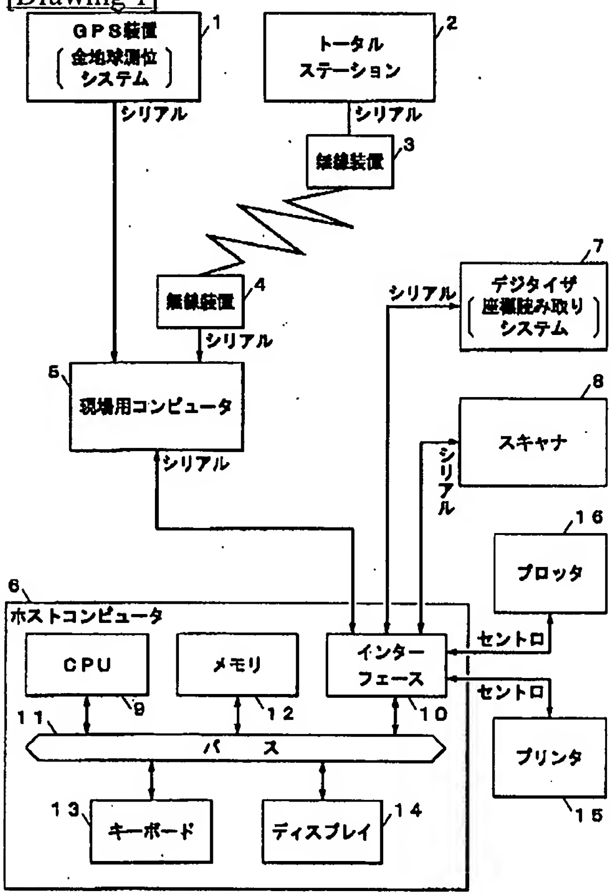
[Date of extinction of right]	

* NOTICES *

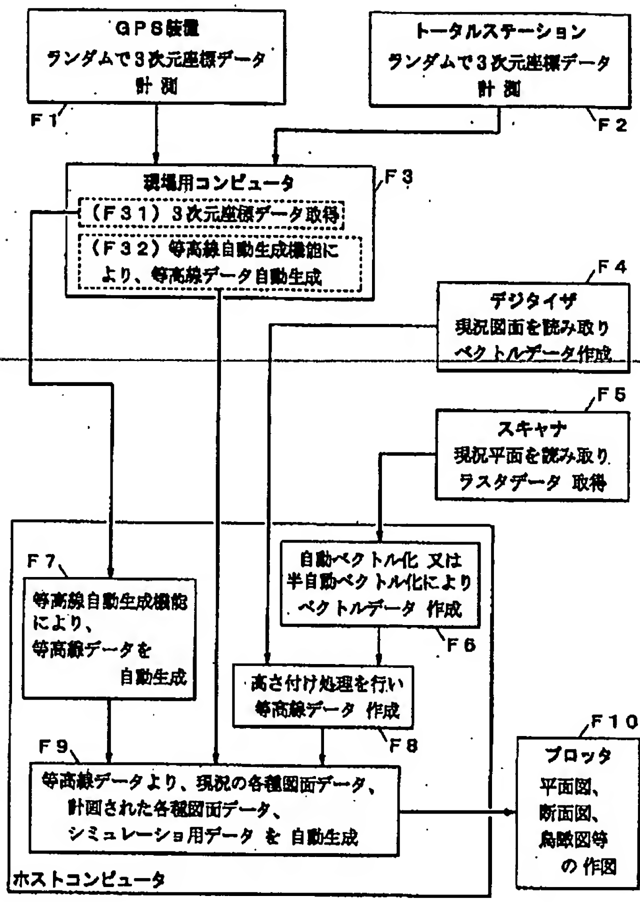
DRAWINGS

[Drawing 1]



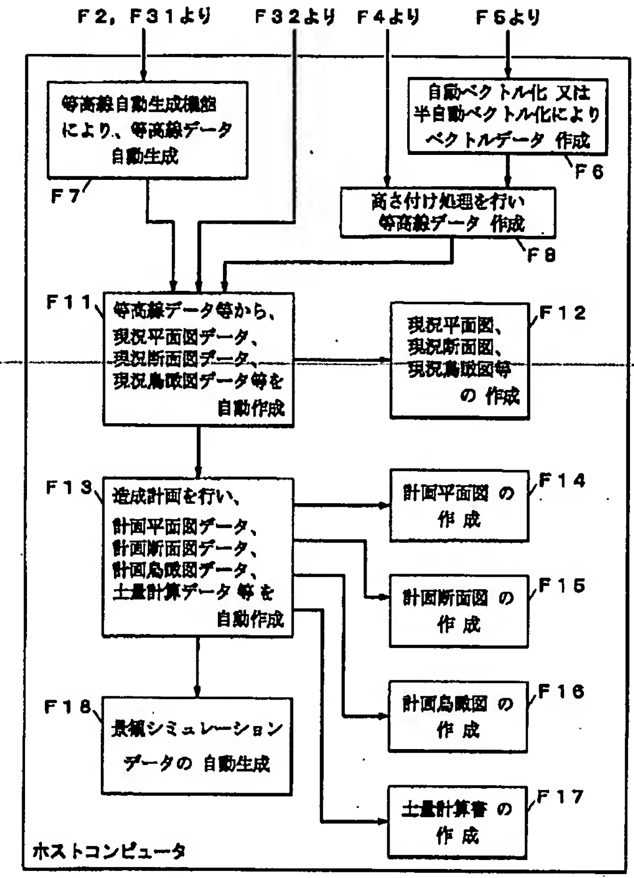
システムブロック図

[Drawing 2]



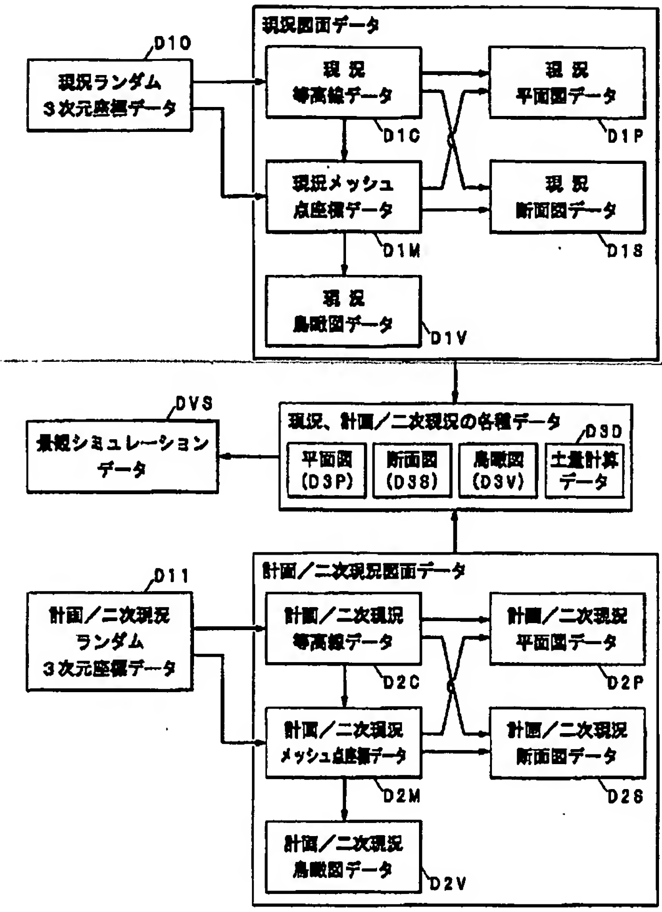
機能ブロック図〔1〕

[Drawing 3]



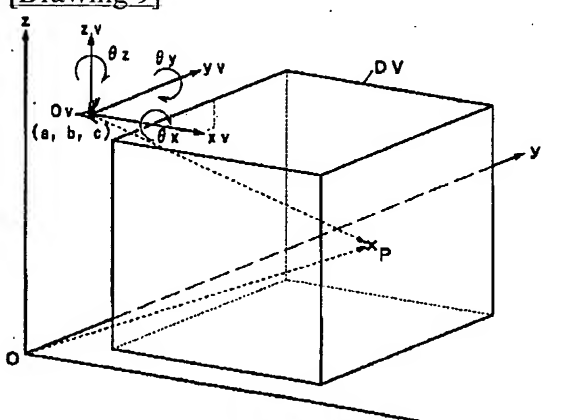
機能ブロック図〔2〕

[Drawing 4]



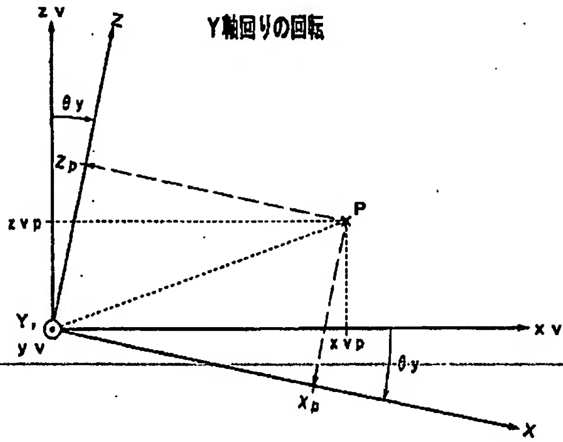
データ遷移図

[Drawing 9]

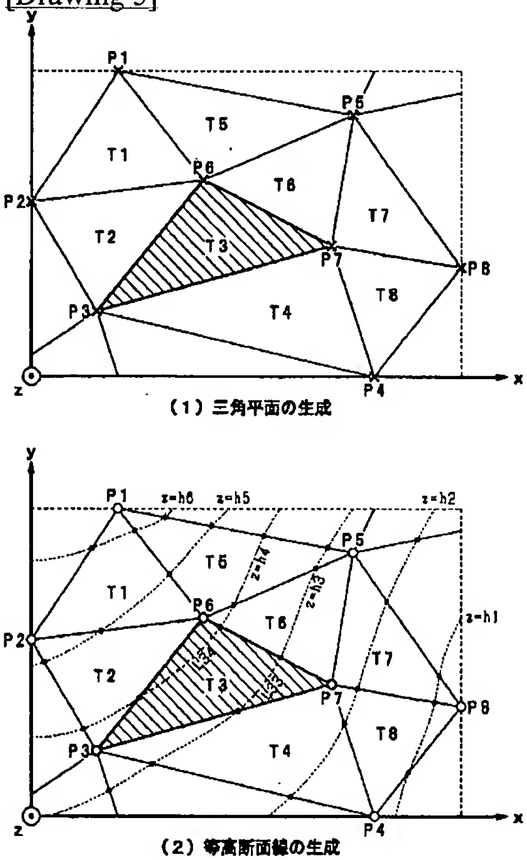


視点座標への移動

[Drawing 10]

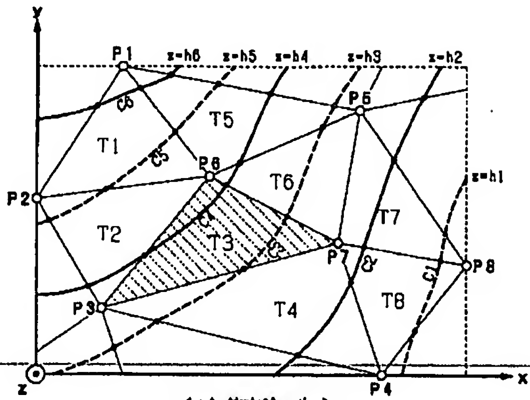


[Drawing 5]

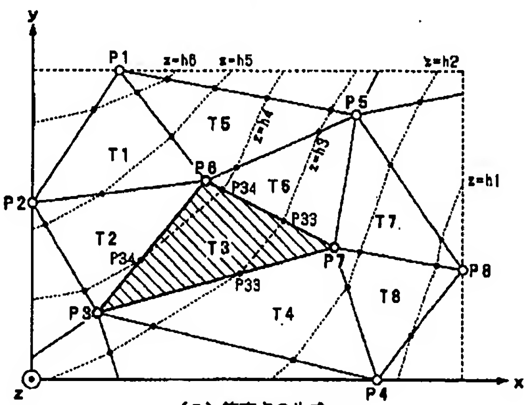


等高線の生成〔1〕

[Drawing 6]



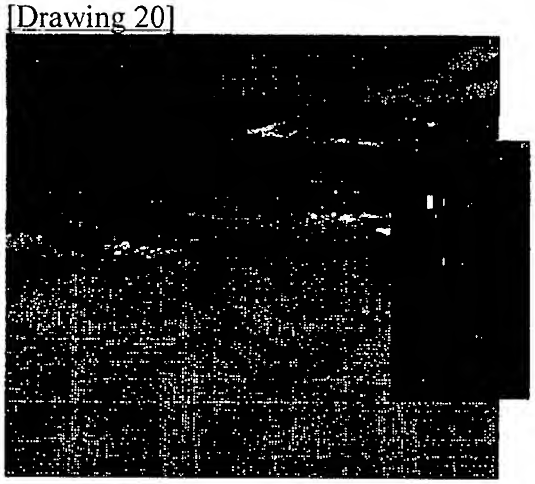
（1）等高線の生成



（2）等高点の生成

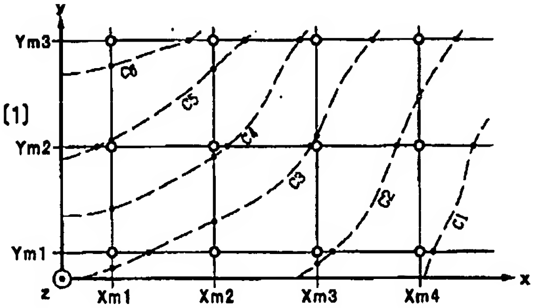
等高線の生成〔2〕

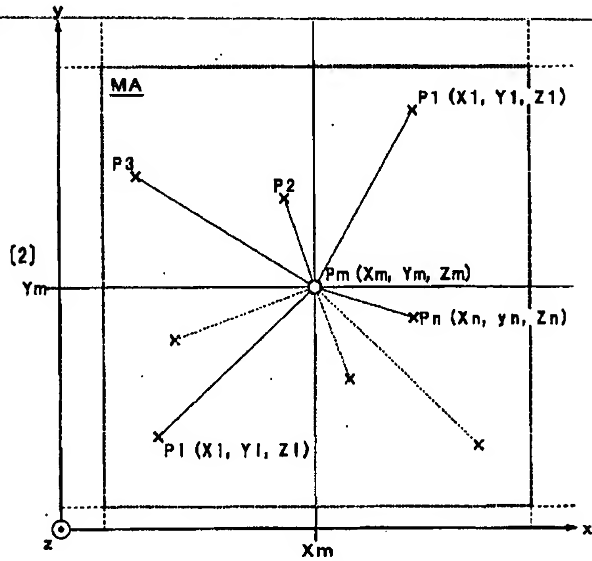
[Drawing 20]



【DVS】景観シミュレーションデータに変換の一例

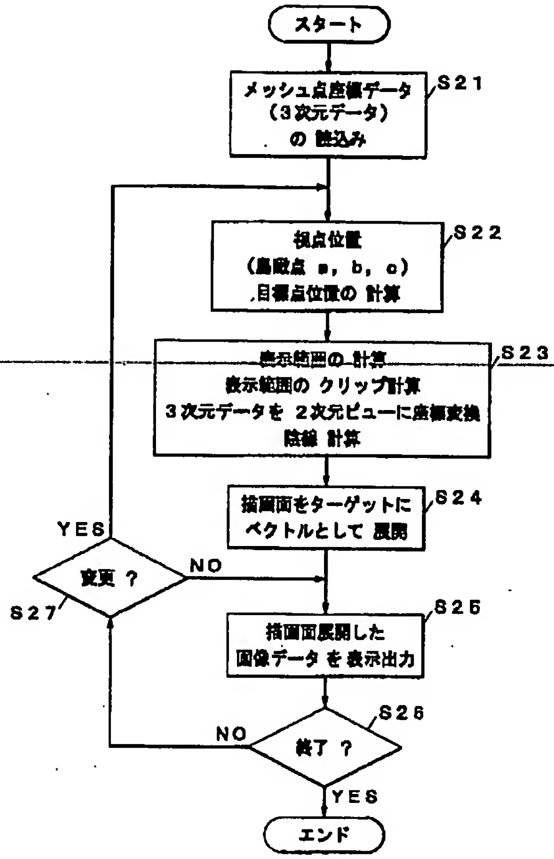
[Drawing 7]





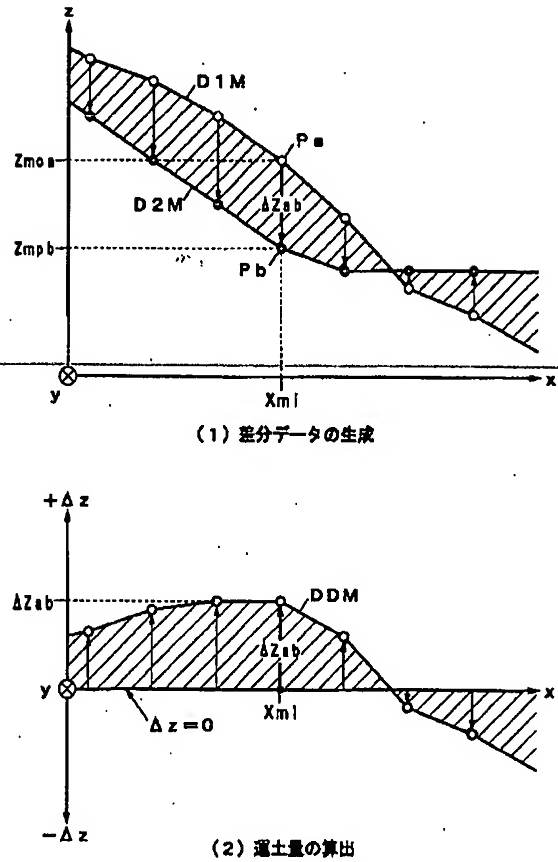
メッシュ点座標データの生成

[Drawing 8]



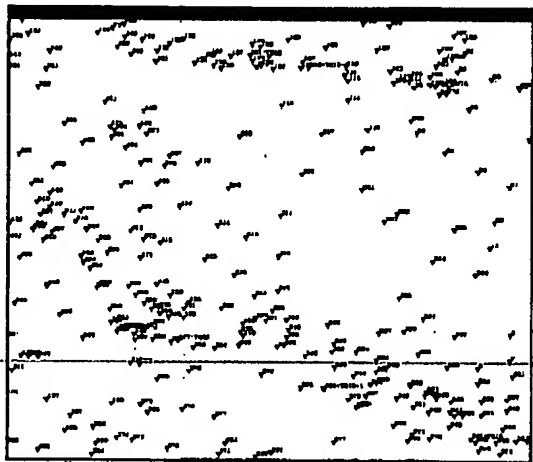
景観シミュレーション処理フロー例

[Drawing 11]

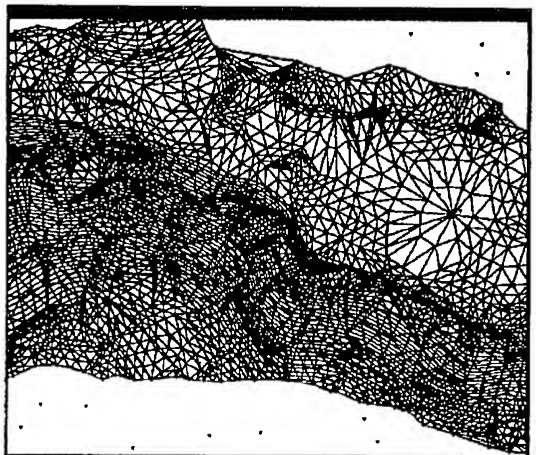


土量の計算

[Drawing 12]

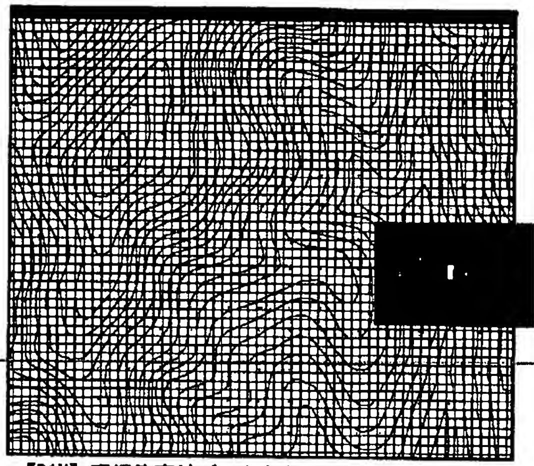


【D10】現況ランダム3次元座標データの一例

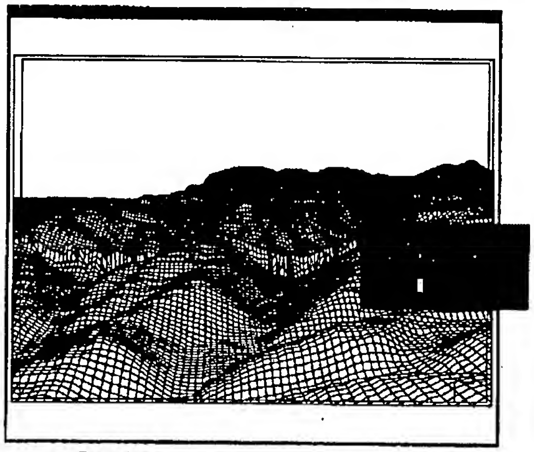


【D1C】現況ランダム３次元座標データから
現況等高線データに変換中の一例

[Drawing 13]

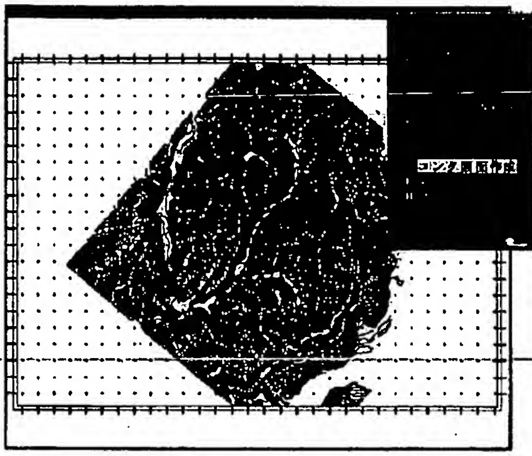


【D1M】現況等高線データから
現況メッシュ点座標データに変換中の一例

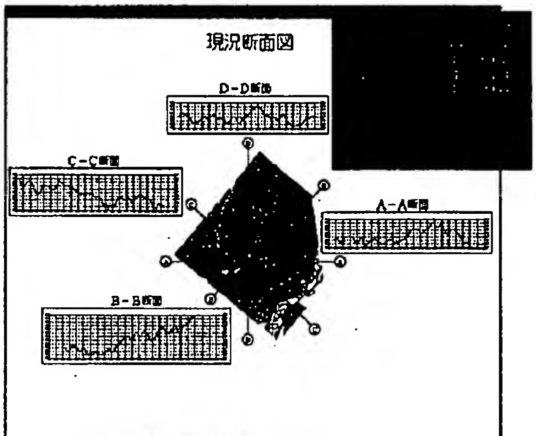


【D1V】現況鳥瞰図データに変換の一例

[Drawing 14]

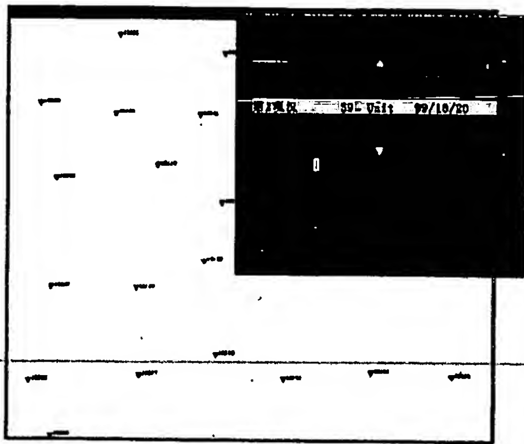


【D1L】現況等高線データから
現況平面図データに変換の一例

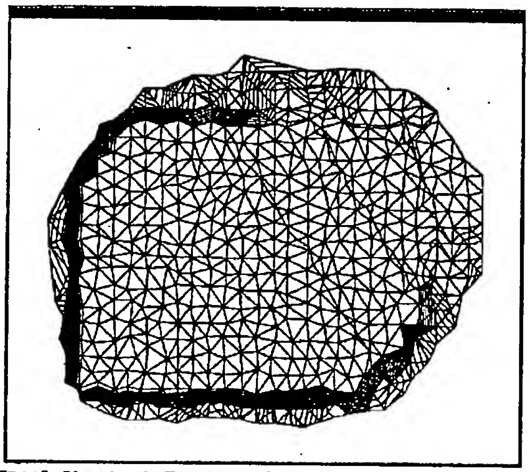


【D1T】現況等高線データから
現況断面図データに変換の一例

[Drawing 15]

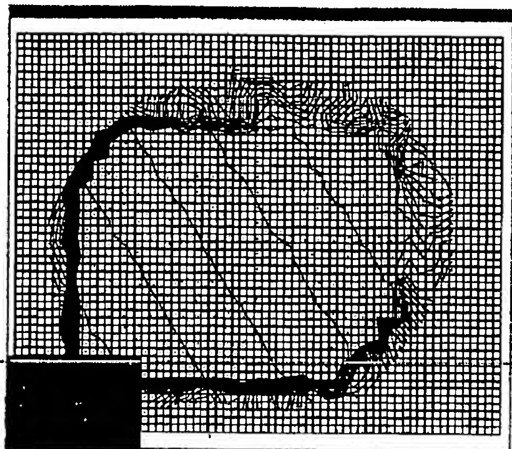


【D11】計画（２次現況）ランダム３次元座標データの一例

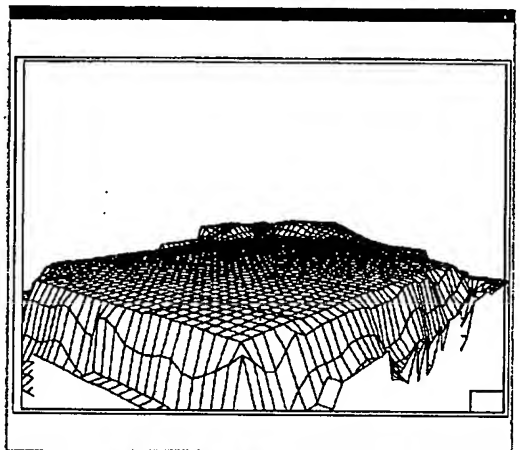


【D11】計画（２次現況）ランダム３次元座標データの一例

[Drawing 16]

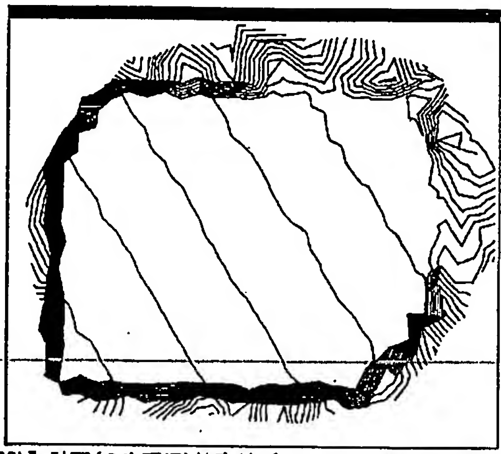


【D2M】計画（２次現況）等高線データから計画（２次現況）メッシュ点座標データに変換中の一例

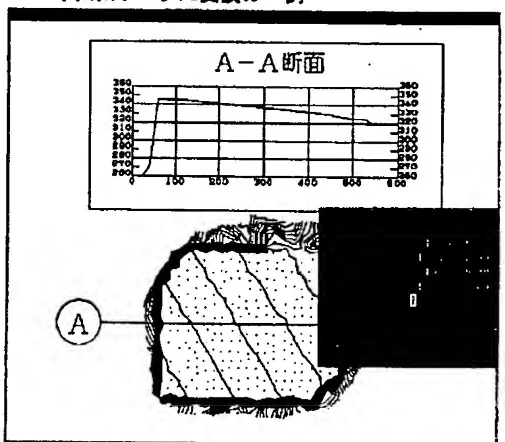


【D2V】計画（２次現況）鳥瞰図データに変換の一例

[Drawing 17]

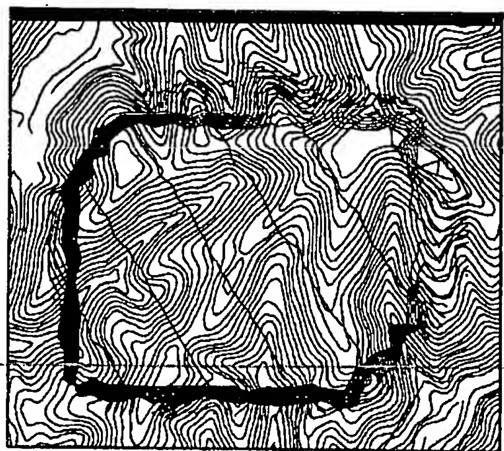


【D2L】計画(2次現況)等高線データから計画(2次現況)平面図データに変換の一例

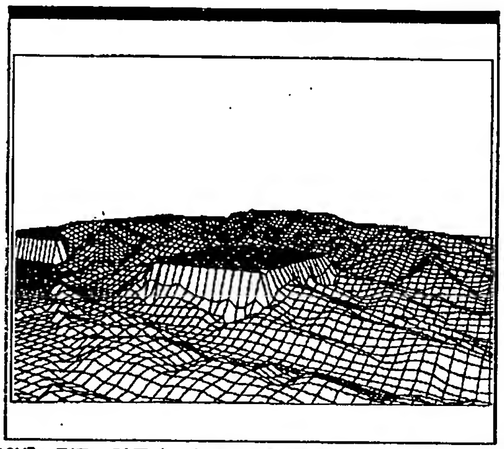


【D2T】計画(2次現況)等高線データから計画(2次現況)断面図データに変換の一例

[Drawing 18]

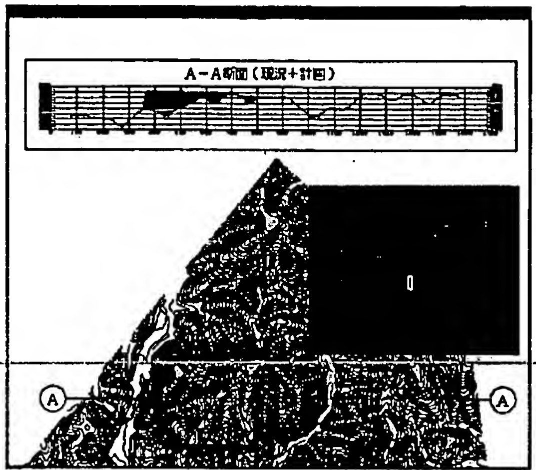


【D3L】 現況＋計画（２次現況）平面図データに変換の一例

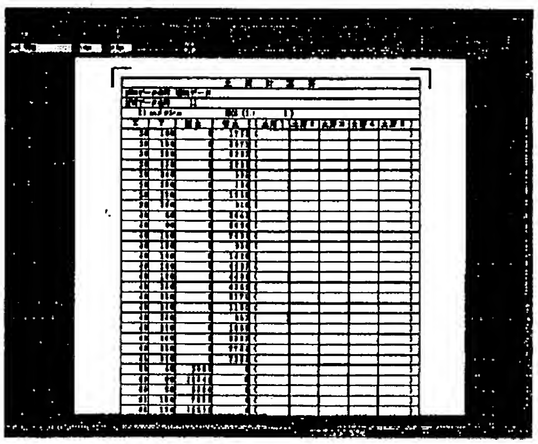


【D3V】 現況＋計画（２次現況）鳥瞰図データに変換の一例

[Drawing 19]



【D3T】現況＋計画（２次現況）断面図データに変換の一例



【D3V】現況＋計画（２次現況）鳥瞰図データに変換の一例

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing 1 is a block diagram showing the overall configuration of the land formation plan computer-aided design by one example of this invention.
[Drawing 2] Drawing 2 is a part of front **************** about the rough function of the land formation plan computer-aided design by one example of this invention.
[Drawing 3] Drawing 3 is the other sections of front **************** about the rough function of the land formation plan computer-aided design by one example of this invention.
[Drawing 4] Drawing 4 is a data transition diagram showing the main transition relation of the main data in one example of this invention.
[Drawing 5] Drawing 5 is some drawings for explaining the high line data generation technique -- it can set in the one example of this invention.
[Drawing 6] Drawing 6 is the other sections of drawing for explaining the high line data generation technique -- it can set in the one example of this invention.
[Drawing 7] Drawing 7 is drawing for explaining the generation technique of the mesh point coordinate data in one example of this invention.
[Drawing 8] Drawing 8 is a flow chart which shows an example of the simulation processing by one example of this invention.
[Drawing 9] Drawing 9 is drawing for explaining count of the shift coordinate transformation in simulation processing.
[Drawing 10] Drawing 10 is drawing for explaining count of the simulation coordinate transformation in simulation processing.
[Drawing 11] Drawing 11 is drawing for explaining the count technique of the soil volume in one example of this invention.
[Drawing 12] Drawing 12 is the 1st example of the display display in one example of this invention.
[Drawing 13] Drawing 13 is the 2nd example of the display display in one example of this invention.
[Drawing 14] Drawing 14 is the 3rd example of the display display in one example of this invention.
[Drawing 15] Drawing 15 is the 4th example of the display display in one example of this invention.
[Drawing 16] Drawing 16 is the 5th example of the display display in one example of this invention.
[Drawing 17] Drawing 17 is the 6th example of the display display in one example of this invention.
[Drawing 18] Drawing 18 is the 7th example of the display display in one example of this invention.
[Drawing 19] Drawing 19 is the 8th example of the display display in one example of this invention.
[Drawing 20] Drawing 20 is the 9th example of the display display in one example of this invention.
[Description of Notations]
P1-P8, Pi, Pn Random point,
T1-T8 Triangle flat surface,
h1-h6 Altitude (z) value,
L33, L34 Profile line of the altitude values h3 and h4 in triangle flat-surface T3,
C1-C6 Contour line,
P33, P34 High points, such as the altitude values h3 and h4 in each side of triangle flat-surface T3.

[Translation done.]

* NOTICES *

~~DETAILED DESCRIPTION~~

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the land formation plan computer-aided design which works a contour-line plot etc. by digital processing based on the digital data obtained from the present condition survey, and the record medium for it.
[0002]
[Description of the Prior Art] For example, when performing the land formation plan design of large-scale lots, such as a residence, an office, and works, generally, on the status board which the survey firm created, the construction consultant firm performed the planned design and the approach of creating a plan top view and a plan sectional view has been used. There are usually no present condition mesh data and present condition contour-line data which are useful to a design, and it is necessary to reinput the data for these creation in that case. For status board creation, after stretching a mesh for the development area flat surface beforehand and defining a land survey point, the present condition survey of geographical feature was performed in the land survey point (or the near) of a spot, the result of such fixed-point surveying was written in each point of a mesh map, the location of a high-grounds [altitude / on a mesh point (intersection)] point was approximated, and the contour-line plot was performed. It is a relative analog survey which used the ranging measurement-of-angle matter, the topographic survey in such a site has a low precision of a survey result considering large-scale equipment, and working efficiency of ** is [a topographic survey] very low. Moreover, since similar fixed-point surveying which defines a land survey point (fixed point) beforehand along the area where the road plan was planned, and performs a present condition survey of geographical feature was performed also when the land formation plan design of lots, such as a road, was performed, there was same fault.
[0003] Moreover, after the contour-line plot, since the geodetic data used for a contour-line plot had not coordinated with a subsequent plot or count also when performing the design of a plot, soil volume calculation, etc. of a plan top view, a plan sectional view, etc., synthetic effectiveness also became very low and the precision which may be satisfied also to a plot or a count result was not acquired. Furthermore, drawings, such as a plan [to be created after a design] top view and a plan sectional view, need to change a design data to three dimensions further, in order to be described two-dimensional and to grasp the situation of the land developed for housing lots by which the planned design was carried out in three dimensions.
[0004] Therefore, a highly precise status board is acquired with sufficient working efficiency, it can coordinate with this, creation of a plan top view or a sectional view and count of various quantity can be performed unitary, a desired three-dimension drawing can be created, and it is just going to wait for the appearance of the system which can be consistent and can process these activities.
[0005]
[Problem(s) to be Solved by the Invention] This invention acquires present condition geographical feature data with high precision and efficiently in view of such a situation. Creation of the plan top view which it designs using this data as it is, and is a design result, or a plan sectional view, With the bird's-eye view thru/or landscape simulation image which can carry out unitary management of many processes which result in creation of three-dimension drawings, such as generation of various quantity count data, and a bird's-eye view, synthetically, can process in a short time, and moreover expresses the planned design region in three dimension It sets it as the main purpose to offer the land formation plan computer-aided design which can perform prior examination of a planned design etc. effectively.
[0006]

[Means for Solving the Problem] A means to acquire the three-dimension coordinate data in a random point if the 1st description of this invention is followed, It is based on a means to generate contour-line data from the acquired three-dimension coordinate data, and high line data, such as having been generated. The land formation plan computer-aided design possessing a means to create flat-surface data, cross-section data, or bird's-eye view data, and the step which acquires the three-dimension coordinate data in a random point, The step which generates contour-line data from the acquired three-dimension coordinate data, Based on high line data, such as having been generated, the record medium for the land formation plan design exchange which is recording the program which consists of the step which creates flat-surface data, cross-section data, or bird's-eye view data is offered. Contour-line data are preferably expressed by the spline curve approximated from the acquired three-dimension coordinate data.

[0007] A means to acquire the three-dimension coordinate data in a random point if the 2nd description of this invention is followed, A three-dimension mesh-data creation means to create three-dimension mesh data based on the acquired three-dimension coordinate data, The land formation plan computer-aided design possessing a means to create bird's-eye view data based on the created three-dimension mesh data, and the step which acquires the three-dimension coordinate data in a random point, The record medium for the land formation plan design exchange which is recording the program which consists of the step which creates three-dimension mesh data based on the acquired three-dimension coordinate data, and the step which creates bird's-eye view data based on the created three-dimension mesh data is offered. A three-dimension mesh-data creation means creates the three-dimension mesh data approximated by the least square method in consideration of distance with the mesh point concerned about two or more three-dimension coordinate data located in each mesh area among three-dimension coordinate data to the acquired things which generate contour-line data and create three-dimension mesh data from high line data, such as having been generated, or the three-dimension coordinate data which were acquired preferably.

[0008] If another description of this invention is followed, when creating bird's-eye view data, a means to display the landscape simulation image corresponding to the created bird's-eye view data further is provided.

[0009] A means to acquire the three-dimension coordinate data in the random point at two or more times if other descriptions of this invention are followed, A means to generate three-dimension mesh data from the acquired three-dimension coordinate data, respectively, The land formation plan computer-aided design which possesses a means to create soil volume data or bowl-capacity-in-loose data, based on the comparison result of the generated 3-dimensional each mesh data, And the step which acquires the three-dimension coordinate data in the random point at two or more times, The step which generates three-dimension mesh data from the acquired three-dimension coordinate data, respectively, Based on the comparison result of the generated 3-dimensional each mesh data, the record medium for the land formation plan design exchange which is recording the program which consists of the step which creates soil volume data or bowl-capacity-in-loose data is offered.

[0010] [Operation of invention] According to the 1st description of this invention, as contour-line data are generated from the three-dimension coordinate data surveyed at the random point and flat-surface data, cross-section data, and bird's-eye view data are created based on this contour-line data, current survey geographical feature data are made to reflect to a top view, a sectional view, or a bird's-eye view faithfully as it is. By using new high precision surveying instruments, such as GPS and a total station (TS), the three-dimension coordinate data which becomes a radical can be surveyed quickly, and it is only surveying a random point and it can survey the survey approach easily in a short time. Furthermore, in a design stage, since a geodetic data can be used as it is, there is no input mistake and a land formation plan design can be performed in a short time. That is, present condition geographical feature data can be acquired efficiently and exactly by conversion to contour-line data from a random geodetic data, and present condition can be checked easily and certainly with a top view, a sectional view, or a bird's-eye view not only at the time of a design but at the time of actual reclamation. Moreover, contour-line data can be easily obtained by expressing by the spline curve approximated from three-dimension coordinate data.

[0011] According to the 2nd description of this invention, it is based on the three-dimension coordinate data surveyed at the random point, and they are three-dimension mesh data (in an example). it is called "mesh point coordinate data." Since current survey geographical feature data are made to reflect to a bird's-eye view faithfully as it is as it generates and bird's-eye view data are created based on these three-dimension mesh data The present geographical feature can be exactly grasped in three dimensions using the bird's-eye view which expressed present condition geographical feature in three dimension it not only acquires present condition

geographical feature data efficiently, but, and, thereby, the present condition check in a design and a reclamation activity can be made still more easily and reliable. Moreover, three-dimension mesh data can be made highly precise by approximating with the least square method in consideration of distance with the mesh point concerned about two or more three-dimension coordinate data which can acquire easily or are located in each mesh area by [, such as having been generated from the three-dimension coordinate data,] creating from high line data.

[0012] Since he is trying to display the landscape simulation image corresponding to bird's-eye view data according to another description of this invention, present condition geographical feature can be grasped exactly in three dimensions, and prior examination of a planned design etc. can be performed effectively. In addition, this landscape simulation image can display grasp of present condition geographical feature in the viewing angle of arbitration from two or more looking down points for much more effective present condition grasp.

[0013] According to other descriptions of this invention, from the three-dimension coordinate data measured at the random point at two or more times Since current geographical feature data are made to reflect to soil volume data or bowl-capacity-in-loose data faithfully as three-dimension mesh data are generated and soil volume data or bowl-capacity-in-loose data is created based on the comparison result of 3-dimensional each mesh data, respectively ** can also compute efficiently the progress situation and **** track record of earthmoving work with high precision by performing the comparison with the data before a design, and the data after a reclamation activity, and the comparison between after [a reclamation activity] data.

[0014]

[Embodiment of the Invention] Hereafter, the suitable example of this invention is explained in full detail, referring to a drawing. In addition, the following examples are mere examples and modification various in the range which does not deviate from the pneuma of this invention is possible for them.

[0015] [Outline of a system] Drawing 1 is a block diagram showing the overall configuration of the land formation plan computer-aided design by one example of this invention. As flow of general processing, present condition geographical feature data are acquired first. Present condition geographical feature is surveyed using GPS (Global Positioning System: Global Positioning System) equipment 1 or the total station (Total Station) 2 as a surveying instrument for this, and this acquires a three-dimension coordinate as present condition geographical feature data. The three-dimension coordinate data with which the three-dimension coordinate data obtained with GPS equipment 1 was obtained through direct serial transmission Rhine at the total station 2 is sent to the computer 5 for sites through each radio equipment 3 and the radio equipment 4 for sites.

[0016] By computer 5 for sites, a contour-line automatic generator generates contour-line (contour) data automatically. After being able to check high line data, such as having been generated automatically here, with a liquid crystal display (not shown) and finishing a check, they are inputted into a host computer 6, for example through serial transmission Rhine from the computer 5 for sites.

[0017] In addition, the three-dimension coordinate data sent to the computer 5 for sites is inputted into a host computer 6, and you may make it generate contour-line data for example, through serial transmission Rhine using the contour-line automatic generation function of a host computer 6 (the direct data entry to the host computer 6 from the total station 2 is omitting illustration).

[0018] To a host computer 6, further, a digitizer 7 and a scanner 8 are connected and the as-built drawing data raster-data-ized from reception and a scanner 8 in the vector-data-ized as-built drawing data can be received from a digitizer 7.

[0019] In a host computer 6, high line data, such as having been obtained through the computer 5 for sites, or three-dimension coordinate data, and the vector data from a digitizer 7 and the raster data from a scanner 8 are once stored in memory 12 through an internal bus 11 under control of a central processing unit (CPU) 9 by survey at GPS equipment 1 or the total station 2 from an interface 10.

[0020] The keyboard 13 and the display 14 are connected to the bus 11, after storing in the memory 12 of various data, CPU9 generates contour-line data automatically from three-dimension coordinate data or vector data based on a contour-line automatic generation function according to actuation of a keyboard 13, and based on a status board creation function, status board data are generated semi-automatically from contour-line data. In addition, by giving the status board creation function in a host computer 6 to the computer 5 for sites, status board data can be created by computer 5 for sites, and it can also constitute so that status board data may be transmitted to a host computer 6.

[0021] Now, with a host computer 6, the planned design of land developed for housing lots is performed based

on the status board data obtained by doing in this way, drawing data, such as a plan top view, a plan sectional view, and bird's-eye view data, and count data, such as soil volume management data, are generated, and various corresponding drawings are plotted by the plotter 16 through an interface 10.

[0022] Furthermore, a host computer 6 generates automatically the mesh point coordinate data after a planned design based on these scheme-drawing data, count data, such as soil volume management data, are generated using both mesh point coordinate data, and various corresponding statements are outputted from a printer 15 or a plotter 16. Moreover, scene simulation data is generated based on the mesh point coordinate data after a planned design. While displaying the landscape simulation image excellent in visibility automatically on a display 14 by this, the bird's-eye view of the arbitration view in a simulation screen etc. can be automatically printed out by the printer 15 using the graphic data corresponding to a screen.

[0023] In addition, it is desirable to use a color laser beam printer, a color ink jet plotter, etc. so that the drawing and document which can distinguish the difference with present condition data, plan data, or data under construction in a color can be outputted to a printer 15 or a plotter 16.

[0024] [Outline of a system function] Drawing 2 and drawing 3 are the functional block diagrams showing the rough function of the land formation plan computer-aided design by one example of this invention.

[0025] GPS equipment 1 (drawing 1) is digital land survey equipment by the GPS method, and a miniaturization is attained by progress of **** better ****** in recent years, measurement actuation is easy, and equipment is also very easy actuation, and, moreover, it can obtain a very highly precise digital geodetic data in a short time. In the one example of this invention, it faces surveying the present condition geographical feature of the plan region, and as functional block F1 shows, highly precise digital three-dimension coordinate data (x (east and west), and [y (north and south), z (altitude)]) is acquired at each random land survey point by performing the land survey of the GPS method by GPS equipment 1 at the point of random arbitration.

[0026] that is, since the so-called "fixed-point surveying" be perform, a mesh at equal intervals be beforehand stretch in the usual present condition survey in the top view of the area set as the object of a land formation plan and it survey considering the mesh point ([xm, ym] = fixed point) which be an intersection of a mesh line as an actual land survey point, depending on the geographical features of a spot, a survey be on difficult geographical feature, or there be a land survey point that it be flat, and be changeless and it be think that it be unnecessary etc. On the other hand, in this invention, a surveying point can be lessened in an area with little altitude change by performing a present condition survey at the random point ([xr, yr] = random any selected point) of the arbitration which is easy to survey without caring about a mesh point, and making a surveying point into many in the area where geographical feature is complicated etc. can survey in consideration of the roughness and fineness of a surveying point consistency. Therefore, without being bound by the survey on a mesh in addition to the high precision three-dimension survey by GPS, the land survey point consistency adjustable survey which thought the changing point of geographical feature as important can be performed, and the survey result of having improved precision further is obtained irrespective of an efficient survey.

[0027] The total station 2 is digital land survey equipment which performs survey data processing with a digital signal using a ranging measurement-of-angle matter, and a comparatively accurate digital geodetic data is obtained by progress of a technique irrespective of small and easy measurement actuation. In the one example of this invention, it faces surveying the present condition geographical feature of the plan region, and as functional block F2 shows, digital three-dimension coordinate data [xr, yr, zr] can be acquired at a random every place point by performing a land survey by the total station 2 at the land survey point of random arbitration. In addition, although each land survey point of GPS equipment 1 or the total station 2 may be random, if mutual physical relationship is selected so that each top-most vertices of the triangle near an equilateral triangle if possible may be accomplished, future processings can be performed with sufficient convenience, and a good processing result can be obtained.

[0028] ** which the personal computer use equipment of the pocket mold called an "electronic plate" can be used, and the computer 5 for sites can collect and arrange the data from each survey equipments 1 and 2, and can add a contour-line automatic generation function by application software further. By such computer 5 for sites, as functional block F3 shows The digital three-dimension coordinate data [xr, yr, zr] (set of the coordinate group which made positional information the real number value of x, y, and z3 component) of the random point [xr, yr] from the land survey equipments 1 and 2 is acquired (F31). Or high line data [a set of a z-coordinate value (altitude), and x and y plane-coordinates value group], such as having expressed each contour line with the sequence-of-points information on a three dimension, are further generated from this data (F32).

[0029] A digitizer 7 is a drawing coordinate read system, and as functional block F4 shows, it generates as-built drawing vector data by reading the coordinate data of an as-built drawing. Moreover, a scanner 8 acquires raster data from a paper drawing, as functional block F5 shows. From these raster data, within a host computer 6, as functional block F6 shows, as-built drawing vector data (present condition vector drawing) is generated by an automatic vectorization (auto vector rise) function or the semi-automatic trace vectorization function. These equipments 7 and 8 are used for acquiring the circumference geographical feature data outside the land formation plan area which cannot be measured with the land survey equipments 1 and 2.

[0030] functional block F8 shows a host computer 6 by the contour-line automatic generation function like to the data which are shown with functional block F7 and which generated contour-line data automatically from the computer 5 for sites, or the present condition random three-dimension coordinate data from the total station 2 (F31), and vectorized the vector data from a digitizer 7, and the raster data of a scanner 8 with functional block F6 -- deed contour-line data are created for height attachment processing of a contour line like. And high line data, such as having done in this way and having been obtained, or the contour-line data already obtained from GPS equipment 1 or the total station 2 (F32) through the computer 5 for sites is the set of x, y, and a z-coordinate group which gave regularity in mesh point coordinate data [x of present condition, and the direction of y as functional block F9 showed. It is also called "mesh data".] The various data for simulation are automatically generated in ****** drawing data, the planned mesh point coordinate data and various drawing data, and a list.

[0031] In addition, although not shown in drawing 2 and drawing 3 , a host computer 6 can be constituted, without using contour-line data so that direct mesh point coordinate data [xm, ym, zm] may be generated from the three-dimension coordinate data [xr, yr, zr] surveyed at the random point, so that it may mention later. Moreover, the various drawing data generated with the host computer 6 are handed to a plotter 16, and thereby, a plotter 16 plots an as-built drawing and plan drawings (a top view, a sectional view, bird's-eye view, etc.) based on drawing data etc., as functional block F10 shows.

[0032] Drawing 3 expresses the processing facility of a host computer 6 more concretely, and the concrete contents of processing in the functional block F9 of drawing 2 are shown by functional block F11-F18. In functional block F11, present condition top view data, present condition sectional view data, present condition mesh point coordinate data [xm, ym, zm], etc. are generated automatically from the present condition random three-dimension coordinate data which becomes the contour-line data of the present condition acquired with functional block F32, F7, and F8, or its radical. In functional block F12, a present condition top view, a present condition sectional view, a present condition bird's-eye view, etc. are created based on present condition contour-line data, present condition mesh point coordinate data, present condition top view data, present condition sectional view data, present condition bird's-eye view data, etc.

[0033] In functional block F13, a land formation plan design is performed according to the plan of land developed for housing lots, referring to present condition each drawing. Plan contour-line data or plan mesh point coordinate data is generated from the three-dimension (it is random) coordinate data created regardless of the mesh point based on the land formation plan, and this creates plan top view data, designed section data, and bird's-eye view data. The created various plan data are handed to a plotter 16 like present condition each drawing data, and a plan top view, a plan sectional view, a plan bird's-eye view, etc. are created so that it may illustrate to functional block F14-F17. Moreover, although not illustrated, various quantity, such as soil volume, is also calculated from the difference of present condition data and plan data, and can carry out the color output of those quantity statements from a printer 15.

[0034] In one example of this invention, based on these scheme-drawing data, further, as shown in functional block F18, the scene (bird's-eye view) simulation data showing the scene which looked at the land formation plan region before and behind a design from the height of arbitration can be generated, and the image by which simulation was carried out can be displayed on a display 14 based on this simulation data. A land formation plan design can be performed efficiently, the scene simulator which can be fed back being realized by this and performing landscape evaluation in a plan process. In addition, print-out or plot out of the predetermined simulation screen can be carried out by the printer 15 or the plotter 16 if needed.

[0035] Thus, various quantity, such as soil volume calculated from the difference of present condition data and plan data, is hammered out by the statement, and the plan which took into consideration the right and wrong of a land formation plan, harmony with a present condition environment, etc. visually is attained by the plan bird's-eye view thru/or the landscape simulation. Moreover, since various statements, a plan bird's-eye view, or scene

simulation data can be created only by reinputting only a modification part when performing a planned design again as a result of this evaluation, a repeat re-degree planned design can be performed and the optimal land formation plan design result can be obtained in a short time.

[0036] [Transition of data] Drawing 4 shows the data transition diagram showing the main transition relation of the main data in one example of this invention. First, present condition three-dimension coordinate data D1O [xr, yr, zr] is acquired, and it is changed into present condition contour-line data D1C by GPS equipment 1 and the total station 2 at the land formation plan ground and the random point in the area in which the observation of the circumference of it is possible by contour-line automatic generation processing of the computer 5 for sites or a host computer 6. Moreover, about the neighboring area in which the observation around the plan ground is possible, present condition contour-line data D1C can be obtained by sticking and reading the existing status board (paper) into a digitizer 7, a host computer's 6 generating deed contour-line data for height attachment processing, or reading the existing status board (paper) with a scanner 8, vectorizing with a host computer 6, and carrying out the semi-automatic input of the height.

[0037] Next, the height [zm] on a break and each mesh point [xm, ym] is deduced for this present condition contour-line data D1C in a mesh. Generate a mesh point coordinate (xm, present condition mesh point coordinate data D1M[xm expressed with ym] and its altitude value [zm], and [ym, zm]), and it carries out present condition contour-line data D1C or based on present condition mesh point coordinate data D1M. Present condition top view data D1P, present condition sectional view data D1S, and present condition bird's-eye view data D1V grade are created. While creating present condition top view D3P, present condition sectional view D3S, and present condition bird's-eye view D3V grade based on these as-built drawing data, the present condition scene simulation data DVS can be created, and this data can perform the display of a present condition scene (bird's-eye view) etc.

[0038] Moreover, in a host computer 6, call as-built drawings and landscape simulation images, such as a present condition bird's-eye view, on a display 14, and present condition is fully grasped. The random three-dimension coordinate data based on a land formation plan (or D11 is created after reclamation) Based on this, plan contour-line data D2C or plan mesh point coordinate data D2M are generated, and the plan drawing data of plan top view data D2P, plan sectional view data D2S, and plan bird's-eye view data D2V grade are generated based on this data D2C and D2M. Plan mesh point coordinate data D2M have the same mesh (spacing) size as present condition mesh point coordinate data D1M.

[0039] And while creating plan top view D3P, plan sectional view D3S, and plan bird's-eye view D3V grade based on these plan drawing data, the plan scene simulation data DVS can be created, the scene (bird's-eye view) of plan land developed for housing lots can be simulated on the display screen, and a plan result can be visually grasped and verified by the three dimension. Moreover, by comparing as-built drawing data and plan drawing data (both mesh point coordinate data), soil-volume-calculation data D3D is computed automatically, and can generate a soil-volume-calculation document.

[0040] In addition, the generation technique and the soil-volume-calculation technique of sectional view data or landscape simulation (bird's-eye view) data which were mentioned above can use effectively also in the reclamation activity after going into an actual reclamation phase after planned design termination further. For example, GPS equipment 1 grade performs a random survey for every [periodically / in a reclamation phase / or] arbitration stage. The secondary present condition random coordinate data D11 by which the after [reclamation] (periodically) survey was carried out is acquired, and secondary present condition contour-line data D2C and secondary present condition mesh point coordinate data D2M are generated based on this coordinate data D11. By this The secondary as-built drawing data of the secondary present condition top view in a reclamation phase, a sectional view and bird's-eye view data D2P, D2S, and D2V grade are obtained. Therefore, based on these secondary as-built drawing data, the scene of the land developed for housing lots of a reclamation phase is simulated by the secondary present condition scene simulation data DVS it not only creates a secondary present condition top view, a sectional view and bird's-eye view D3P, D3S, and D3V, but, or secondary present condition soil-volume-calculation data D3D showing the soil volume in a reclamation phase is obtained.

[0041] For example, secondary as-built drawing data can be called on a display 14 with as-built drawing data or plan drawing data, or the secondary as-built drawing data at the different survey time can be called to coincidence, and the progress situation of reclamation can be exactly grasped by comparing data. For example, change of geographical feature can be visually checked by contrast of a landscape simulation (or bird's-eye

view plot). Moreover, a soil-volume-calculation document can be easily drawn up by the comparison of mesh point coordinate data.

[0042] [Generation of contour-line data] It can set in the one example of this invention, and random three-dimension coordinate data D1O and contour-line data D1C from D11 which were surveyed / set up by contour-line automatic generation processing at the random point, and D2C can be generated comparatively with high precision. Drawing 4 and drawing 5 are drawings for explaining such contour-line data generation technique, and, theoretically, contour-line data are generated as follows. first, drawing 5 (1) -- like -- three-dimension system of coordinates (x, and [y, z]) -- setting -- the random three-dimension coordinate data D1 -- the random points P1 and P2 which the coordinate value [xr, yr, zr] of O and D11 expresses, and -- are connected mutually, ~~and the triangle plane groups T1 and T2 and -- which become a configuration nearest to an equilateral triangle~~ are formed.

[0043] Next, fixed height spacing deltah which has predetermined height (altitude) z=h1, h2 and h3, and -- for these triangle plane groups T1 and T2 and -- (deltah=h2-h1=h3-h2=--.) For example, it cuts at the [x, y] flat surface of every deltah=25cm, and the random (not restrained by the mesh) profile line of height regularity (h1, h2, h3, --) is generated. If it illustrates about triangle flat-surface T3, the profile line L33 of altitude z=h3 and the profile line L34 of altitude z=h4 will be generated like drawing 5 (2).

[0044] And like drawing 6 (1), sequential connection of the profile lines with equal height (L33, L34 grade) is carried out from the starting point to a terminal point, it considers as each contour line C1 and C2 and --, these contour lines C1 and C2 and -- are gathered, and what carried out the sequential array of the [x, y] coordinate value serves as contour-line data at every contour-line altitude value [z].

[0045] In order to enforce concretely the method of generating such contour-line data, the following simple technique is employable. Namely, on each side of the triangle flat surfaces T1 and T2 acquired by drawing 5 (1), and --, from a neighboring both-ends coordinate, as shown at drawing 6 (2) High points, such as predetermined height z=h1, h2 and h3, and -- (z=h3 and h4 are received about triangle flat-surface T3) Interpolation interpolation of the points P33 and P34 is carried out, sequential connection of the high points, such as the same altitude value, is carried out from the starting point to a terminal point, and if the spline curve which passes along high points, such as these equivalents, is made to draw, the contour lines C1 and C2 shown in drawing 6 (1) and the almost same contour-line data as -- will be obtained with a sufficient precision.

[0046] [generation of mesh point coordinate data] -- one example of this invention -- setting -- mesh point coordinate data D1M and D2 -- it is also directly generable from M (random three-dimension coordinate data D1O surveyed / set up at also asking for xm, ym, and zm] from contour-line data D1C and D2C, and a random point, D11[xr, and [yr, zr]). Drawing 7 shows an example of these approaches and drawing 7 [1] is illustrating the approach of calculating the each mesh point [altitude [Zm] value in Xm1 and Ym1]- [Xm4, Ym3] from the contour-line data C1-C6. That is, the altitude value [Zm] in the mesh point [Xm3, Ym2] which exists during both intersections is computable like drawing 7 [1] by carrying out equal interpolation of the difference in elevation of both the contour-lines data C2 and C3 in the intersection of two contour-line data C2 and C3 and mesh configuration lines Ym2 simply.

[0047] When generating directly from random three-dimension coordinate data [xr, yr, zr], as mesh point coordinate data can be obtained simply and it is shown in drawing 7 [2], it can also compute comparatively with high precision using a least square method etc. by carrying out equal interpolation from the coordinate value of three points which form the minimum triangle surrounding the [xm, ym] coordinate of each mesh point [xm, ym, zm]. Namely, the inside of the random point expressed with three-dimension coordinate data in three-dimension system of coordinates (x, and [y, z]), The points P1, P2, --, Pn which exist in the mesh area MA of predetermined [x, y] coordinate range surrounding a certain mesh point Pm [Xm, Ym, Zm] are taken up. The mesh point altitude value Zm which minimized the error is computed with a least square method based on the three-dimension coordinate value [Xi, Yi, Zi] of these points P1-Pn.

[0048] That is, it is from flat-surface equation z=ax+by+c about the altitude value Zm of the mesh point Pm [Xm, Ym, Zm]. Zm = aXm + bYm + c -- (1)
then, if approximated with the least square method in consideration of distance with the three-dimension coordinate data [Xr, Yr, Zr] (= -- P1 [X1, Y1, Z1] - Pi[Xi, Yi, Zi] - Pn [Xn, Yn, Zn]) in the two or more n random point Pr distributed in the mesh area space MA : which can ask for each multipliers a, b, and c by the following formula (1) - the formula (4) -- [Equation 1]

$$a = \frac{\sum_{i=1}^{n}(Z_i-\overline{Z})(X_i-\overline{X})\sum_{i=1}^{n}(Y_i-\overline{Y})^2-\sum_{i=1}^{n}(X_i-\overline{X})(Y_i-\overline{Y})\sum_{i=1}^{n}(Y_i-\overline{Y})(Z_i-\overline{Z})}{\sum_{i=1}^{n}(X_i-\overline{X})^2\sum_{i=1}^{n}(Y_i-\overline{Y})^2-\{\sum_{i=1}^{n}(X_i-\overline{X})(Y_i-\overline{Y})\}^2} \quad \cdots\cdots (2)$$

[Equation 2]

$$b = \frac{\sum_{i=1}^{n}(Y_i-\overline{Y})(Z_i-\overline{Z})\sum_{i=1}^{n}(X_i-\overline{X})^2-\sum_{i=1}^{n}(X_i-\overline{X})(Y_i-\overline{Y})\sum_{i=1}^{n}(Z_i-\overline{Z})(X_i-\overline{X})}{\sum_{i=1}^{n}(X_i-\overline{X})^2\sum_{i=1}^{n}(Y_i-\overline{Y})^2-\{\sum_{i=1}^{n}(X_i-\overline{X})(Y_i-\overline{Y})\}^2} \quad \cdots\cdots (3)$$

[Equation 3]

$$c = z - (a\overline{X})(b\overline{Y}) \quad \cdots\cdots (4)$$

However, [Equation 4]

$$\overline{X} = \frac{\sum_{i=1}^{n} X_i}{n}, \quad \overline{Y} = \frac{\sum_{i=1}^{n} Y_i}{n}, \quad \overline{Z} = \frac{\sum_{i=1}^{n} Z_i}{n} \quad \cdots\cdots (5)$$

[0049] [Landscape simulation] In one example of this invention, in order to verify a design object visually, the landscape simulation which displays a planned bird's-eye view image on a display 14 can be performed by generating the scene simulation data DVS. Drawing 8 is a flow chart which shows an example of the simulation processing for obtaining the bird's-eye view data thru/or simulation data based on one example of this invention, and drawing 9 and drawing 10 are drawings for explaining the coordinate count in this simulation processing.

[0050] As already explained, present condition mesh point coordinate data D1M About the circumference area which can measure the land formation plan ground and its neighborhood It is generated based on the ****** contour-line data obtained from present condition three-dimension coordinate data D1O in the random point from GPS equipment 1 or the total station 2 by carrying out height attachment processing from a digitizer 7 or a scanner 8 to data about an immeasurable circumference area. Moreover, plan / secondary measurement mesh point coordinate data D2M are generated as three-dimension data DV from plan data or secondary measurement data (D11, D2C). In this simulation processing, these mesh point coordinate data D1M and D2M are incorporated as three-dimension data DV. Therefore, at the 1st step S21 of this processing flow, in order to perform present condition, a plan, or a secondary present condition landscape simulation, the three-dimension data DV defined as a location on a three-dimension coordinate (x y, z) are read.

[0051] At the following step S22, a target point location is calculated based on the bird's-eye view view location Ov and viewing angle which were directed in the keyboard 13 grade. First, like drawing 9 , the predetermined bird's-eye view view location Ov (a, b, c) on a three-dimension coordinate (x y, z) is defined, and the location on the three-dimension data DV (x y, z) is changed into a view position coordinate (a, b, c) at the shift system of coordinates (xv, yv, zv) which carried out zero migration. Thereby, a location (x y, z) is shifted by each axial locations xv, yv, and zv expressed with degree type (6) - (8). : xv = x - a -- (6)
yv = y - b -- (7)
zv = z - c -- (8)

[0052] Thus, it considers as the reference point of coordinate count by making a view position coordinate (a, b, c) into a zero. The shift system of coordinates (xv, yv, zv) shifted from the system of coordinates (x y, z) of the three-dimension data DV Furthermore, make the view location Ov into the center of rotation, and it responds to the include angle (viewing angle) of a view. To the circumference of a x axis (east-and-west directional axis) at the circumference of an include angle theta x and the y-axis (north-south directional axis) Include-angle thetay, Only include-angle thetaz is leaned to the circumference of the z-axis (perpendicular direction shaft) (- pi<theta

x, thetay, theta z<pi). The target point location on the leaned three-dimension system of coordinates (X, Y, Z) is calculated, and these three-dimension system of coordinates (X, Y, Z) are henceforth used as simulation system of coordinates used as the former coordinate for creating bird's-eye view data or simulation data.
[0053] For example, when only include-angle thetay rotates to the circumference of the y-axis, simulation system of coordinates (X, Y, Z) are expressed like drawing 10 to shift system of coordinates (xv, yv, zv). The location (xvp, yvp, zvp) of the target point P on shift system of coordinates is changed into the location (Xp, Yp, Zp) on the simulation system of coordinates expressed with degree type (9) - (11). : Xp = xvp-cos(thetay)-zvp-sin (thetay) -- (9)
Yp = yvp -- (10)
Zp = xvp-sin(thetay)+zvp-cos (thetay) -- (11)
[0054] Moreover, when only an include angle theta x is rotated to the circumference of a x axis, the location (xvp, yvp, zvp) of the target point P on shift system of coordinates (xv, yv, zv) is similarly changed into the location (Xp, Yp, Zp) on the simulation system of coordinates (X, Y, Z) expressed with degree type (12) - (14). : Xp = xvp -- (12)
Yp = yvp-cos(theta x)-zvp-sin (theta x) -- (13)
Zp =-yvp-sin(theta x)+zvp-cos (theta x) -- (14)
[0055] furthermore, when only include-angle thetaz rotates to the circumference of the z-axis It is made the same. The location [xvp, yvp, zvp] of the target point P on shift system of coordinates [xv, yv, zv] Degree type (15) It is changed into the location [Xp, Yp, Zp] on the simulation system of coordinates (X, Y, Z) expressed with - (17).: Xp = xvp-cos(thetaz)+yvp-sin (thetaz) -- (15)
Yp =-xvp-sin(thetaz)+yvp-sin (thetaz) -- (16)
Zp = zvp -- (17)
[0056] Thus, count of the view location [a, b, c] of arbitration and the target point location of the three-dimension data DV on the simulation system of coordinates [X, Y, Z] on the basis of a viewing angle (theta x, thetay, thetaz) changes the three-dimension data expressed with these simulation system of coordinates [X, Y, Z] into the two-dimensional view coordinate for projecting on a two-dimensional view screen in step S23. Here, in consideration of the scale of the drawing which draws, the display rectangle to a drawing thru/or a screen is calculated, clip count of a display rectangle is performed, and it changes into a final screen system two-dimensional view coordinate. Furthermore, a hidden line is calculated according to the size of the depth value (Z value = the depth from a view location to each target position is expressed) acquired on the occasion of the coordinate transformation to a two-dimensional view, and hidden-line-removal processing is performed. Thus, although the obtained vector data for drawing is used for generation of the scene simulation data after degree step S24, it is applicable also to creation of the bird's-eye view by the plotter 16.
[0057] In step S24, by using a screen as a target, it is developed by image data (bit map data, for example, BMP file data) (drawing), and the vector data by which view coordinate transformation was carried out is the following step S25, and a display output is carried out on a display 14 based on this drawing data. Moreover, this display drawing data can be saved in memory 12 as scene simulation data if needed. Furthermore, in step S26, it judges whether simulation processing is ended, when ending (YES), this processing is ended, and when continuing, it progresses to step S27 at (NO).
[0058] When it progresses to step S27, it is this step S27 and judges whether there were any directions of display modification (simulation by another bird's-eye view view location Ov [a, b, c] or another viewing angle). And the same processing is repeated at steps S22-S25 or step S25 until it will return to step S22 if there are these directions, and it will judge it as processing termination at return and step S26 to step S25, if there is nothing.
[0059] [Prediction count of soil volume] In one example of this invention, as mentioned above, soil volume and bowl capacity in loose can be calculated from the difference of present condition data and plan data, and the prediction statement of that quantity can be outputted from a printer 15. For example the plan mesh point coordinate data D2, after making each mesh coordinate point [xmp, ymp] of M (xmp, ymp, zmp] and present condition mesh point coordinate data D1M[xmo, and [ymo, zmo]), and [xmo, ymo] in agreement, respectively and expressing the same mesh point [xm, ym] From difference deltaz of the both data D2 altitude [z] coordinate values zmp and zmo which compares M and D1M and corresponds among both difference -- mesh point coordinate data DDM [xm, ym, delta z], and [xm=xmo=xmp, ym=ymo=ymp, deltaz=zmp-zmo] -- asking -- this difference -- the total soil volume is computable from the volume between the field expressed by mesh point

coordinate data DDM and the flat surface of deltaz=0.
[0060] Drawing 11 shows drawing for explaining the count technique of such soil volume, and the coordinate of the direction perpendicular to space of y is omitting the display in this drawing for simplification of explanation. after [as mentioned above,] making in agreement, respectively each mesh coordinate point expressed with the [x, y] coordinate value as plan mesh point coordinate data D2M and present condition mesh point coordinate data D1M are shown in drawing 11 (1) -- both -- it asks for the difference of the altitude coordinate value of the direction of the z-axis which corresponds between data D2M and D1M. for example, the difference of the altitude value Zmoa of a certain mesh point Pa of plan mesh point coordinate data D2M [Xm1, Ym1], and the altitude value Zmpb of the same mesh point Pb of present condition mesh point coordinate data D1M corresponding to this [Xm1, Ym1] -- delta z=delta Zab=Zmoa-Zmpb is calculated. such difference -- computing deltaz about all mesh points [xm, ym] -- difference -- mesh point coordinate data DDM [xm, ym, delta z] is acquired. and it is shown in drawing 11 (2) -- as -- difference -- the difference expressed by mesh point coordinate data DDM [xm, ym, delta z] -- the total soil volume Vt is computed from the volume between a field and the flat surface of deltaz=0.
[0061] thus, deltaz among the total soil volume Vt computed -- forward difference -- volume [drawing 11 between a field and z= delta0 flat surface (1) -- The amount VL 1 of cutting to which cutting of left-hand side slash section] of (2) is carried out from present condition geographical features is expressed. deltaz -- negative difference -- the amount VL 2 of landfill which the volume between a field and z= delta0 flat surface [the right-hand side slash section of drawing 11 (1) and (2)] raises the level with fill in present condition geographical features is expressed, and the removal soil volume Vd from which the difference of the amount VL 1 of cutting and the amount VL 2 of landfill should be removed outside the area is expressed. Therefore, various earthmoving work schedules, such as determining the total number of the truck for removal which should allocate cars based on this removal soil volume Vd, determining **** days from the number for removal of a truck which can allocate cars, and determining the number from the amount VL 2 of landfill the bulldozer total which should allocate cars, can be set up. furthermore, difference -- the planned distribution condition of the amount of cutting or the amount of landfill can also be expressed in a top view or a bird's-eye view from mesh point coordinate data DDM and present condition mesh point coordinate data D1M, or plan mesh point coordinate data D2M.
[0062] In one example of this invention, the generation technique and the soil-volume-calculation technique of sectional view data or landscape simulation (bird's-eye view) data which were mentioned above can use effectively also in the reclamation activity after going into an actual reclamation phase after planned design termination further. What is necessary is for that, for GPS equipment 1 grade to perform a random survey for every [periodically / in a reclamation phase / or] arbitration stage, and just to obtain secondary present condition mesh point coordinate data D11 grade based on a periodical survey result. The progress situation of reclamation can be exactly grasped by comparing the secondary present condition various data obtained at the time of each survey, or comparing secondary present condition data with present condition data or plan data.
[0063] About soil volume calculation, the advance situation (the track record value and predetermined value of the total soil volume, the amount of cutting, and the amount of landfill) of earthmoving work can be grasped by computing a soil volume difference by calling in piles the mesh point coordinate data obtained at the time of each survey, and plan mesh point coordinate data D2M or present condition mesh point coordinate data D1M, for example. Moreover, the soil volume difference of a between is computable at both the times by calling secondary present condition mesh point coordinate data in piles, when different from the secondary present condition mesh point coordinate data at a certain time (for example, one month after reclamation initiation) (for example, two months after reclamation initiation). furthermore, the difference which compares secondary present condition mesh point coordinate data, and is obtained when different from the secondary present condition mesh point coordinate data obtained at the time of a certain survey -- the soil volume change distribution map at the time of corresponding can be created using mesh point coordinate data.
[0064] [Various examples of drawing] Drawing 12 - drawing 20 show one example of the data displayed on a display 14 for an understanding of the display gestalt in data, and the drawing and the screen which are dealt with in one example of this invention, a drawing, or an image. "D1O" of drawing 12 shows an example of the screen display of present condition random three-dimension coordinate data D1O, and "D1C" shows the example of the display screen under conversion to present condition contour-line data D1C from present condition random three-dimension coordinate data D1O. "D1M" of drawing 13 shows the example of a display

screen under conversion to present condition mesh point coordinate data D1M from present condition contour-line data D1C, and "D1V" is an example of the present condition bird's-eye view created based on present condition mesh point coordinate data D1M. on the other hand, "D1L" of drawing 14 shows the example of a screen display of present condition top view data D1P created based on present condition contour-line data D1C, and "D1T" follows profile line A-A of present condition contour-line data D1C, B-B, and -- each -- signs that present condition sectional view data D1S are generated are expressed.
[0065] "D11" of drawing 15 shows an example of the screen display of the plan (or secondary present condition) random three-dimension coordinate data D11, and "D2C" shows the example of the display screen under conversion to plan (or secondary present condition) contour-line data D2C from the plan (or secondary present condition) random three-dimension coordinate data D11. "D2M" of drawing 16 shows the example of a display screen under conversion to plan (or secondary present condition) mesh point coordinate data D2M from plan (or secondary present condition) contour-line data D2C, and "D2V" is an example of a plan [to be created based on plan (or secondary present condition) mesh point coordinate data D2M] bird's-eye view. On the other hand, "D2L" of drawing 17 shows the example of a screen display of plan (or secondary present condition) top view data D2P created based on plan (or secondary present condition) contour-line data D2C, and "D2T" expresses signs that plan (or secondary present condition) sectional view data D1S according to profile line A-A of plan (or secondary present condition) contour-line data D2C are generated.
[0066] the example of 1 display at the time of "D3L" of drawing 18 generating top view data D3P (D1 P+D2P) based on present condition top view data D1P and plan (or secondary present condition) top view data D2P -- expressing -- **** -- both -- the top view all over the districts which is made to pile up data D1P and D2P mutually simply, and includes land developed for housing lots and the circumference is shown. Here, top view data D3P of the whole region after a planned design are obtained by deleting the data of the point range [x, y] same among present condition data D1P as plan (or secondary present condition) data D2P. Moreover, "D3V" of drawing 18 expresses the example of 1 display of bird's-eye view data D3V (D1 V+D2V) of the whole region after a planned [to be generated based on present condition mesh point coordinate data D1M and plan (or secondary present condition) mesh point coordinate data D2M] design. after these data D3V delete the data of the point [x, y] same among present condition data D1M as plan (or secondary present condition) data D2M -- both -- it is simply obtained by combining data D1M and D2M.
[0067] "D3T" of drawing 19 It is made to be the same as that of line data D3C(D1C+D2C) [data D3P and D3V. having piled up present condition top view data D1P and plan (or secondary present condition) top view data D2P etc. -- high -- Signs that plan (or secondary present condition) sectional view data D3S (D1 S+D2S) according to profile line A-A of generable] are generated are expressed. Moreover, "D3D" of drawing 19 is the display screen showing one example of the soil-volume-calculation document drawn up from soil-volume-calculation data D3D generated according to the point of the soil volume calculation mentioned above based on present condition mesh point coordinate data D1M and plan (or secondary present condition) mesh point coordinate data D2M.
[0068] Drawing 20 shows an example of the bird's-eye view simulation image displayed on a display 14 based on the scene simulation data DVS. On a display 14, without taking aerial photograph to the land developed for housing lots of present condition, a plan, or secondary present condition, and its circumference, the three dimension scene image from various view locations (looking down point) is displayed, and, moreover, actuation of rotation, zoom-in, etc. can be applied free to a scene image. Moreover, automatic print-out or plot out of the bird's-eye view image of the arbitration view in a plan landscape simulation screen can be carried out as a bird's-eye view by the printer 15 or the plotter 16 using the graphic data corresponding to a screen at the time of the need. Thus, since the bird's-eye view image of the land developed for housing lots which carried out the planned design was displayed in order to perform visual verification of a design object, three-dimensional grasp of land developed for housing lots can be performed much more exactly, and it becomes synthetically possible to verify the right and wrong of a plan, harmony with a circumference environment, etc.
[0069] [Effect of the Invention] -- according to this invention, as contour-line data are generated from the three-dimension coordinate data surveyed at the random point and flat-surface data are created based on this contour-line data, current survey geographical feature data are made to reflect in a top view faithfully as it is, as explained above By using new high precision surveying instruments, such as GPS and a total station, the three-dimension coordinate data which becomes a radical can be surveyed quickly, and it is only surveying a random point and it can survey the survey approach easily in a short time. Furthermore, in a plan design stage, since a

geodetic data can be used as it is, there is no input mistake and a land formation plan design can be performed in a short time. That is, present condition geographical feature data can be acquired efficiently and exactly, and a present condition check can be made easily and reliable also not only in a planned design activity but in a reclamation activity. Moreover, contour-line data can be easily obtained by expressing by the spline curve approximated from three-dimension coordinate data.

[0070] Moreover, according to this invention, generate three-dimension mesh data from the three-dimension coordinate data surveyed at the random point, and bird's-eye view data are created based on these three-dimension mesh data. Since the present survey geographical feature data are made to reflect to a bird's-eye view faithfully, it not only acquires present condition geographical feature data efficiently, but it can grasp the present geographical feature exactly in three dimensions using the bird's-eye view which expressed present condition geographical feature in three dimension. By this The present condition check in a planned design activity or a reclamation activity can be made still more easily and reliable. Three-dimension mesh data can be made highly precise by approximating with the least square method in consideration of distance with the mesh point concerned about two or more three-dimension coordinate data which can acquire easily or are located in each mesh area by [, such as having been generated from the three-dimension coordinate data,] creating from high line data. In this invention, further, by displaying the landscape simulation image corresponding to bird's-eye view data, present condition geographical feature can be grasped exactly in three dimensions, and prior examination of a planned design etc. can be performed effectively.

[0071] furthermore, in this invention, from the three-dimension coordinate data measured at the random point at two or more times Generate three-dimension mesh data and soil volume data and bowl-capacity-in-loose data are created based on the comparison result of 3-dimensional each mesh data, respectively. Since current survey geographical feature data are made to reflect to soil volume data or bowl-capacity-in-loose data faithfully as it is ** can also compute efficiently the progress situation or **** track record of soil volume calculation or earthmoving work with high precision by performing the comparison with the data before a planned design activity, and the data after a reclamation activity, and the comparison between after [a reclamation activity] data.

[0072] As mentioned above, since according to this invention the survey geographical feature data of present condition are acquired with high precision and efficiently, contour-line data and mesh data are generated, using this data as it is and it is made to create flat-surface data, bird's-eye view data, soil volume data, bowl-capacity-in-loose data, etc., it can coordinate with a planned [to carry out based on contour-line data or mesh data] design activity well. Therefore, unitary management can be synthetically carried out including many processes in a subsequent planned design, and short-time processing is enabled.

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] Land formation plan computer-aided design characterized by providing a means to acquire the three-dimension coordinate data in a random point, a means to generate contour-line data from the acquired three-dimension coordinate data, and a means to create flat-surface data, cross-section data, or bird's-eye view data based on high line data, such as having been generated.
[Claim 2] Contour-line data are land formation plan computer-aided design according to claim 1 characterized by being expressed by the spline curve approximated from the acquired three-dimension coordinate data.
[Claim 3] Land formation plan computer-aided design characterized by providing a means to acquire the three-dimension coordinate data in a random point, a three-dimension mesh-data creation means to create three-dimension mesh data based on the acquired three-dimension coordinate data, and a means to create bird's-eye view data based on the created three-dimension mesh data.
[Claim 4] A three-dimension mesh-data creation means is land formation plan computer-aided design according to claim 3 which generates contour-line data from the acquired three-dimension coordinate data, and is characterized by creating three-dimension mesh data from high line data, such as having been generated.
[Claim 5] A three-dimension mesh-data generation means is land formation plan computer-aided design according to claim 3 characterized by creating the three-dimension mesh data approximated by the least square method in consideration of distance with the mesh point concerned about two or more three-dimension coordinate data located in each mesh area among the acquired three-dimension coordinate data.
[Claim 6] Furthermore, land formation plan computer-aided design given in any 1 term of claims 1-5 characterized by providing a means to display the landscape simulation image corresponding to the created bird's-eye view data.
[Claim 7] Land formation plan computer-aided design characterized by providing a means to acquire the three-dimension coordinate data in the random point at two or more times, a means to generate three-dimension mesh data from the acquired three-dimension coordinate data, respectively, and a means to create soil volume data or bowl-capacity-in-loose data based on the comparison result of the generated 3-dimensional each mesh data.
[Claim 8] The record medium for the land formation plan design exchange characterized by recording the program which consists of the step which acquires the three-dimension coordinate data in a random point, the step which generates contour-line data from the acquired three-dimension coordinate data, and the step which creates flat-surface data, cross-section data, or bird's-eye view data based on high line data, such as having been generated.
[Claim 9] The record medium for the land formation plan design exchange characterized by recording the program which consists of the step which acquires the three-dimension coordinate data in a random point, the step which creates three-dimension mesh data based on the acquired three-dimension coordinate data, and the step which creates bird's-eye view data based on the created three-dimension mesh data.
[Claim 10] The record medium for the land formation plan design exchange characterized by recording the program which consists of the step which acquires the three-dimension coordinate data in the random point at two or more times, the step which generates three-dimension mesh data from the acquired three-dimension coordinate data, respectively, and the step which creates soil volume data or bowl capacity in loose based on the comparison result of the generated 3-dimensional each mesh data.

[Translation done.]